these mountains, but, like the highways of the Incas, they lead the traveller close by the gates of death, and as a Spanish artillery regiment toils up the wooded slopes with its howitzers and ammunition wagons, their vanguard is suddenly greeted by a shower of rifle-balls from the head of a tanglewood gully, where big ledges of rock and the barricades of fallen trees form an effectual bulwark against a counter-attack.

"Forward! Push ahead all you can!" cries the commanding officer after a brief halt and a hasty survey of the situation. "Hurry up! There comes another shower! More hail and no weather-shed. Carraxo! those fellows have sharpshooters and repeating rifles!"

The artillerymen close their ranks and trudge forward across corpses and scattered baggage till at a turn of the road they are confronted by a barricade of felled trees, and the alternative of facing about and galloping their horses down hill, or halting to be shot down like wolves in a trap. Their pioneers try to remove the obstruction, but find that it will be a work of hours, and report accordingly, while volley after volley rings out from the rocks above, till the council of officers decides to order a retreat.

Besides these tanglewood gullies there are tree-shrouded ruins; and caves—often groups of limestone caverns with connecting tunnels and hidden outlets, where a hundred sharpshooters can hold their own against an army corps.

These caves that are found along the slopes of the Sierra throughout its enormous extent of seven hundred and fifty miles, afford the native rangers a welcome retreat from the showers of the rainy season, while the lack of topographical knowledge often obliges their enemies to bivouac in the midst of the dripping forests, where in the intervals of drenching rains mosquitoes descend like a shower of hot ashes, while ants and chigoes explore the undergarments of the would-be sleeper.

The consequent disorders are aggravated by the malarious effects of bad drinking-water, not to mention such trifles as the circumstance that "not less than fourteen kinds of poisonous fruits and berries bear a close resemblance to edible varieties," as the author of a work on the flora of the West Indies informs us.

No troops recruited among the natives of the temperate zone can stand the hardships of a protracted campaign in a country of that sort, and the average term of endurance is about three months for the hardy Catalan highlanders and four months for the weaker but more sun-seasoned natives of southern Spain.

The Cuban Creoles, on the other hand, actually enjoy their warpath outings, as their forefathers enjoyed their campaigns against the Spanish Moors and the legions of the Corsican Cæsar. They are, moreover, sustained by the sympathy of nearly all their West Indian neighbors, and will achieve their independence if one of their revolts should ever, for a few months, be aided by an uprising of the Spanish Republicans.

FELIX OSWALD.

CHEMISTS AS LEADERS.

THE historians of human development speak of the Stone Age, the Bronze Age, the Iron Age, and other ages, meaning thereby the successive periods of human activity that have been characterized by the use of these

materials. The most fitting term to apply to the period which began between fifty and a hundred years ago, and whose development is yearly more rapid and more wonderful, would be "The Chemical Age."

In the past, while what was called philosophy marked a high mental activity, much of it was a form of thought based almost entirely on abstract speculation, for the study of matter and its changes was almost unknown. Instead of the exact observation of material objects and their behavior under varying conditions, and the study of the phenomena of Nature, all kinds of imaginative trains of thought were evolved, and speculations, often baseless, were put forward with little idea as to whether they were supported or not by facts. Even when facts were observed, they were often distorted in order to make them accord with the false or visionary philosophy of the day. But when the delicate balance was invented, and the weights of the different kinds of matter could be exactly determined, and their changes followed with precision, the great principle of the indestructibility of matter was established, and the schools of abstract philosophy suffered an overturn. Instead of the observed fact being subservient to the speculation, the observed fact became dominant, and speculative philosophy retained its value only so far as it accorded with and explained, or amplified by inference, the fact.

All this bears directly upon the conditions of modern competitive life. For instance, men, first of all, must obtain food. To obtain it from weaker communities by force or robbery could be successful only for a time, as the producers were either exterminated or they gave up so unprofitable an industry. The food-supply of mankind depends on the application of a knowledge of the principles involved in plant-growth. The basis of this knowledge is chemistry. It was not really until 1840 that it was demonstrated by the great chemist, Liebig, that plants, like animals, feed. They take certain kinds of nutriment out of the soil, and soon exhaust it. Soon they fail to grow. Liebig showed that if these nutritive substances were put back into the soil, the plants would keep on growing, and that there was no limit to the productiveness of the earth, when properly nourished as chemical science indicated. Malthus stated that the population must be restricted, else it would exceed the food supply. Liebig showed that the production of food stuffs, made possible by the application of chemical science, was so immense that such a danger is not to be feared. Chemical knowledge has rendered it possible to make several blades of grass grow where there was only one. Liebig then investigated live stock and proved that, though animals eat many kinds of food, the food owed its value to a few definite nutritive elements that are found in greater or less amounts in all foods; and that the animals, though seemingly widely different in physiological nature, were composed essentially of the same substances. Thus the raising of live stock and the production of dairy products were placed upon a scientific basis. Agriculture began to employ scientific methods and the cost of raising plants and animals was greatly reduced.

It is not always easy to appreciate at first glance the far-reaching effect of a chemical discovery. The introduction of the hot blast in the manufacture of iron increased the production of pig iron. The invention by Bessemer of the converter method of making steel practically revolutionized the manufacturing industry of the whole world. What cheap steel means to humanity could not be told in a large volume. The invention of the basic process for treating phosphatic iron ores by Thomas and Gilchrist

made it possible to produce steel from ores existing in immense quantities and hitherto entirely worthless. And strange to say, phosphorus, the "iron master's curse," is now obtained as a phosphatic slag, which is a most valuable fertilizer for the farmer. The chemist turned the bane of England's iron industry into a blessing to England's agriculture. Weldon utilized the waste product in the manufacture of chlorine, so that it could be used over and over again. In turn was reduced the price of bleach, of bleached white cotton and of white paper. Books were made cheaper. Education was cheapened. The waste tars of the gas manufacture under the skillful hands of a host of chemists are now the basis of an immense industry. They produce brilliant dyes, perfumes, antiseptics, medicaments, and what not. The astonishing development of chemical knowledge has assisted in the evolution of electricity, the commercial future of which is incalculable. The study of life has been taken up, and by the aid of the colossal genius of Pasteur, disease in plants, animals, and men is checked and avoided, thousands of lives are yearly saved, and the tenure of human existence is far stronger than it was half a century ago. Many pages could be written to illustrate how far-reaching and how little short of marvellous have been the modern advances in chemical science and their applications. But they have taken place so quietly, although irresistibly, that the average individual does not appreciate the part they are playing; nor can we estimate the still greater part they are to play. Another striking instance of the results of chemical research is the development on the one side of explosives and on the other of hard and tough steel. Without the assistance of the chemist war would be monotonous.

The stability of a community lies in its independence. Its independence is based on its productiveness. Manufacturing consists in changing one kind of form of matter into some other kind of form. It is easy to understand, therefore, that chemistry, the science that studies the changes in the identity of matter, underlies the manufacturing arts. Hence the industrial status of a nation may be fairly estimated by the condition of its chemical knowledge. It is fair to hold that the country that has the best chemists will in the long run be the most prosperous and the most powerful. It will have at the lowest cost the best food, the best clothing, the best manufactured materials, the fewest wastes and unutilized forms of matter, the best guns, the strongest explosives, the most resistant armor. Its inhabitants will make the best use of their country's resources; they will be the most healthy, the most free from disease; they will oppose the least resistance to favorable evolution; they will be the most thrifty and the least dependent on other nations. The education of its people in chemistry and the physical sciences is the most paying investment that a country can make. Competition to-day between nations is essentially a competition in the science and applications of chemistry.

It is fair to assume, also, that if men who have devoted their lives to the study and practice of chemical science, and who hence must have the clearest understanding of all men of the true relations existing both between material things and between material things and humanity, also possess the mental calibre that may enable them to be men of affairs, they ought to be especially successful in executive positions. Such an assumption is supported by the fact that the number of responsible positions, at first sight quite unconnected with chemistry, which at present are filled by chemists, or men who have received a thorough training, is large. This shows, not

that the chemist is an unusual kind of man, but that a chemical education may make a man unusually efficient. Perhaps as striking an illustration of this as any is the increasing number of chemists in charge of large educational institutions. There is no position in which a man may more powerfully and so lastingly influence man than that of the head of a large school or college.

The Marquis of Salisbury, Prime Minister of England, is a chemist, and spends much of his spare time, when he has any, in his finely-appointed laboratory. And France now places in the most intricate and difficult of positions, that of Minister of Foreign Affairs, her most eminent chemist, Berthelot.

These are signs of the time; indications of the chemical age that the world has now entered into, and in which it is destined to remain for many years to come. It will be interesting to watch the course of the two great nations which are now under the guidance of chemists—bearing in mind that Germany is now the home of chemistry, nor forgetting that Russia's advance in chemistry during the last quarter of a century may fairly be called phenomenal.

In this connection it may be pertinent to ask what has become of all the clever and earnest young Japanese chemists who have been studying at the leading educational centres of Europe and America during the last years?

PETER TOWNSEND AUSTEN.